FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 10 No. 24, November, 2026, pp 39 – 43
DOI: https://doi.org/10.33003/fjs-2026-1022-5560

Farmers' Willingness to use Digital Extension Tools and its Effect on Rice Output in Lafia Local Government Area, Nasarawa State, Nigeria

***Yusuf Abdulrafiu Tayo, Adejoh Stella Ojone, Anamayi Ezra Sokogaye, Salami Abubakar Onoja, Labaga Jonah, Akeremale Adekemi Oluranti and Usman Mbebsuswe Patience**

[1]Department of Agricultural Economics and Extension, Faculty of Agriculture, Federal University of Lafia, Nasarawa State, Nigeria.

*Corresponding authors' email: a.yusuf@agric.fulafia.edu.ng
ORCID: https://orcid.org/0000-0001-5789-5202

Received: 20 Jul. 2026
Accepted: 05 Nov. 2026
Published: 07 Nov. 2026

ABSTRACT
This study assessed farmers' willingness to use digital extension tools and its effect on rice output in Lafia Local Government Area (LGA), Nasarawa State, Nigeria. Primary data were collected from 100 rice farmers selected through a multi-stage sampling procedure and analysed using descriptive statistics, a five-point Likert scale, and ordinary least squares (OLS) regression. Results showed that farmers were predominantly male (64%), married (68%), and middle-aged (mean age = 43 years), with a mean farm size of 1.4 ha and 14 years of farming experience. The mean willingness index was 3.87 (SD = 0.74), indicating moderate-to-high willingness, with perceived ease of use ranked lowest (mean = 3.58). The OLS model explained 56.1% of the variance in rice output ($R^2 = .561$; $F(6, 93) = 19.847$; $p < .001$). Willingness was the strongest standardised predictor of output ($\beta = .404$; $p < .001$), followed by farm size ($\beta = .381$; $p < .001$), educational level ($\beta = .218$; $p = .006$), extension contact ($\beta = .187$; $p = .018$) and farming experience ($\beta = .174$; $p = .024$); age was not a significant predictor. The study concludes that farmers' willingness to use digital extension tools significantly enhances rice output in Lafia LGA and recommends digital literacy training, subsidised rural internet access, and the integration of digital advisory services into formal extension delivery.

Keywords: Digital extension tools, willingness, rice output, OLS regression, smallholder farmers, Nigeria

INTRODUCTION

Digital transformation of agricultural extension is increasingly viewed as a pathway to closing persistent yield gaps among smallholder rice farmers in Nigeria, yet whether farmers are actually willing to embrace these tools, and whether that willingness translates into measurable gains in output, remains insufficiently understood at the local government level. Agricultural extension remains one of the most critical institutional mechanisms for improving farmers' productivity, food security, and rural livelihoods, and access to extension services has been shown to generate substantial welfare benefits for Nigerian farming households (Aremu & Reynolds, 2024). Conventional public extension systems in many developing countries, however, face severe structural constraints, including underfunding, shortages of field extension personnel, and poor rural infrastructure, which collectively limit effective farmer outreach and advisory service delivery (Anteneh & Melak, 2024; Aremu & Reynolds, 2024). The rapid advancement of information and communication technologies (ICTs) has opened transformative pathways for extension delivery through digital extension tools , mobile phones, short message services (SMS), mobile agricultural applications, WhatsApp advisory groups, social media platforms, and internet-based advisory services , which have demonstrated measurable positive effects on farmers' knowledge, technology adoption, and crop yields in multiple developing-country contexts (FAO, 2022; Karki Nepal *et al.,* 2025; Sen *et al.,* 2024; Waje *et al.,* 2024).

Rice (Oryza sativa L.) is one of the most important food crops in Lafia LGA and across Nasarawa State, constituting a primary source of caloric intake and household income for smallholder farming families. Despite favorable Guinea Savannah agroecological conditions, average rice yields in the LGA remain at 1.5–2.2 tonnes per hectare, substantially below the achievable potential of 4–6 tonnes per hectare for improved varieties, a productivity gap consistent with the low rice yields documented among Nigerian smallholders more generally (Amoussohoui *et al.,* 2024; FAO, 2022). This persistent yield gap is largely attributable to limited access to timely agricultural information on improved varieties, fertilizer application, integrated pest management, water management, and post-harvest handling , precisely the categories of information that digital extension tools are designed to deliver (Amoussohoui *et al.,* 2024; Karki Nepal *et al.,* 2025). Although mobile connectivity has expanded rapidly across Nigeria and Sub-Saharan Africa in recent years (GSMA, 2024; Nigerian Communications Commission [NCC], 2024), the translation of digital access into active willingness to use these platforms for agricultural extension purposes has not been automatic or universal (Abioye *et al.,* 2024; Sen *et al.,* 2024).

Farmers' willingness to use digital extension tools refers to their psychological readiness, positive attitude, and behavioral intention to adopt and consistently utilize digital platforms as channels for accessing agricultural advisory information (Abioye *et al.,* 2024; Sen *et al.,* 2024). Willingness is theoretically distinct from mere access or awareness: a farmer may own a mobile phone and have network connectivity yet remain unwilling to use it for extension purposes because of negative perceptions, low trust in digital information, or insufficient digital literacy

(Amoussohoui *et al.,* 2024; Sen *et al.,* 2025). While a growing international literature documents the positive effects of digital extension on agricultural productivity (Karki Nepal *et al.,* 2025; Waje *et al.,* 2024), and Nigerian studies have examined the adoption of specific digital platforms (Abioye *et al.,* 2024; Akinwale *et al.,* 2023; Amoussohoui *et al.,* 2024), the mechanism linking farmers' willingness to use digital tools and actual rice output in the specific context of Lafia LGA remains insufficiently understood.

The study draws on the Technology Acceptance Model (TAM), which posits that perceived usefulness and perceived ease of use jointly shape a user's attitude toward a technology and, in turn, behavioral intention to use it, and which has been widely applied to farmers' acceptance of digital agricultural technologies in developing countries (Davis *et al.,* 2023). Recent empirical evidence supports the willingness–output pathway examined here: digitally supported rice farmers in Nepal achieved 35–56% higher yields than a reference group (Karki Nepal *et al.,* 2025), agricultural information provision significantly increased smallholders' technology adoption and yields in Ethiopia (Waje *et al.,* 2024), and Nigerian rice farmers' perceptions of the usefulness of the RiceAdvice digital advisory application were central to its adoption (Amoussohoui *et al.,* 2024), together indicating that farmers who are more receptive to digital advisory channels obtain and apply better production information, with measurable consequences for output.

This study therefore examined farmers' willingness to use digital extension tools and its effect on rice output in Lafia LGA, Nasarawa State, Nigeria, by describing the socio-economic characteristics of rice farmers in the study area, assessing the level of farmers' willingness to use digital extension tools, and determining the effect of farmers' willingness to use digital extension tools on rice output, against the null hypothesis that farmers' willingness to use digital extension tools has no significant effect on rice output in Lafia LGA

MATERIALS AND METHODS

The Study Area

The study was conducted in Lafia LGA, the administrative headquarters of Nasarawa State, Nigeria, lying approximately between latitudes 8°20′N and 8°36′N and longitudes 8°25′E and 8°41′E. The LGA has an estimated population of approximately 430,000 people, with agriculture as the primary occupation of about 65% of the rural population (National Population Commission [NPC], 2023). It lies within the Guinea Savannah agro-ecological zone, with annual rainfall of 1,200–1,400 mm, mean annual temperatures of 27–32°C, and well-drained ferality soils suitable for rice cultivation (Nigerian Meteorological Agency [NiMet], 2024); the main cropping season extends from April to October.

Sampling Technique and Data Collection

A multi-stage sampling procedure was employed. In Stage I, five rice-producing communities , Gadabuke, Sabon Tasha, Agyaragu, Shabu, and Kwandere , were randomly selected from the Nasarawa Agricultural Development Programme (NADP) community register using simple random sampling without replacement. In Stage II, twenty rice farmers were selected from each community using systematic random sampling from the NADP rice farmer registers, yielding a sample of 100 respondents. Primary data on socio-economic characteristics, willingness, and rice output for the 2024/2025 cropping season were collected using a structured questionnaire.

Method of Data Analysis

Descriptive statistics (frequency, percentage, and mean) were used to describe the socio-economic characteristics of respondents (Objective i). A five-point Likert scale was used to assess willingness (Objective ii), with the decision criterion: mean ≥ 3.50 = willing; mean < 3.50 = not willing; the overall willingness index was computed as the mean across all Likert items. Ordinary least squares (OLS) regression was used to determine the effect of willingness on rice output (Objective iii). All analyses were performed using IBM SPSS Statistics Version 26. The population regression model, estimated for each sampled farmer i (i = 1, 2, …, 100), was specified as:

$$Yi = \beta 0 + \beta 1X1i + \beta 2X2i + \beta 3X3i + \beta 4X4i + \beta 5X5i + \beta 6X6i + \varepsilon i \quad (1)$$

where Y_i = rice output of the *i*th farmer (kg/season); X_{1i} = willingness index (composite Likert score, 1–5); X_{2i} = age (years); X_{3i} = educational level (years of formal schooling); X_{4i} = farm size (hectares); X_{5i} = farming experience (years); X_{6i} = extension contact (visits per year); β_0 = intercept; β_1–β_6 = partial regression coefficients measuring the marginal effect of each explanatory variable on rice output, holding other factors constant; and ε_i = the stochastic error term, assumed to be independently and normally distributed with a mean of zero and constant variance. Equation (1) was estimated by OLS, and the fitted model was diagnosed for multicollinearity using variance inflation factors (VIF) prior to interpretation

RESULTS AND DISCUSSION

Socio-Economic Characteristics of Respondents

Table 1 presents the socio-economic profile of the 100 rice farmers surveyed. Male respondents constituted 64% of the sample, consistent with the male-dominated socio-demographic profiles reported in recent Nigerian smallholder digital-agriculture studies (Abioye *et al.,* 2024; Makwin *et al.,* 2024). The modal age bracket was 41–50 years (32%), with a mean age of 43 years, indicating that rice farming in the study area is driven mainly by middle-aged adults, a profile comparable to those reported for smallholder digital extension users elsewhere (Sen *et al.,* 2024). Most respondents (68%) were married, and mean household size was about six persons, providing substantial family labour for rice cultivation. Educational attainment was moderate , 59% had at least secondary education , which has positive implications for digital extension tool adoption, since education has been found to significantly increase farmers' willingness to adopt digital application tools in Nigeria (Abioye *et al.,* 2024; Makwin *et al.,* 2024). Mean farming experience was 14 years and mean farm size 1.4 hectares, consistent with the smallholder structure of Nigerian rice production (Amoussohoui *et al.,* 2024). Only 40% had access to credit, and extension contact was low (34% received no visit in the previous year), reflecting the limited extension coverage documented for Nigeria (Aremu & Reynolds, 2024).

Table 1: Socio-Economic Characteristics of Respondents (n = 100)

Variable	Category	Frequency	Percent (%)
Gender	Male	64	64.0
	Female	36	36.0
Age (years)	Below 30	10	10.0
	31–40	26	26.0
	41–50	32	32.0
	51–60	20	20.0
(Mean = 43 years)	Above 60	12	12.0
Marital status	Married	68	68.0
	Single	14	14.0
	Widowed	12	12.0
	Divorced	6	6.0
Household size (persons)	1–4	28	28.0
	5–10	52	52.0
(Mean = 6 persons)	Above 10	20	20.0
Educational level	No formal education	11	11.0
	Primary	30	30.0
	Secondary	33	33.0
	Tertiary	26	26.0
Farming experience (years)	1–5	12	12.0
	6–10	22	22.0
	11–20	38	38.0
	21–30	20	20.0
(Mean = 14 years)	Above 30	8	8.0
Farm size (ha)	< 0.5	14	14.0
	0.5–1.0	36	36.0
	1.1–2.0	32	32.0
(Mean = 1.4 ha)	Above 2.0	18	18.0
Access to credit	Yes	40	40.0
	No	60	60.0
Extension contact (visits/yr)	None	34	34.0
	1–2	44	44.0
	3 and above	22	22.0
Cooperative membership	Yes	54	54.0
	No	46	46.0

Source: Field Survey, 2026

Level of Farmers' Willingness to Use Digital Extension Tools

Table 2 presents the weighted mean scores and rankings for the seven Likert-scale willingness statements. All seven statements recorded mean scores above the 3.50 agreement threshold, indicating that the majority of sampled rice farmers demonstrated positive willingness attitudes toward digital extension tool use. The mean willingness index across all items was 3.87 (SD = 0.74), classifying the overall willingness level as moderate-to-high. The statement 'I am willing to use digital tools to access agricultural information' recorded the highest mean (4.09), suggesting broadly positive attitudes toward digital extension engagement in principle, while 'Digital extension tools are easy for me to understand and use' recorded the lowest mean (3.58), reflecting perceived complexity as the primary psychological barrier, consistent with the central role that TAM assigns to perceived ease of use in shaping acceptance (Davis *et al.,* 2023). These findings mirror the gap between positive behavioural intention and constrained actual use that has been documented among smallholder users of digital extension services in developing countries (Sen *et al.,* 2024, 2025), and suggest that a conducive attitudinal environment exists for scaling digital extension in Lafia LGA, provided infrastructure and digital literacy barriers are addressed.

Table 2: Level of Farmers' Willingness to Use Digital Extension Tools

Willingness statement	Mean	SD	Rank	Decision
I am willing to use digital tools to access agricultural information	4.09	0.70	1st	High
I believe using digital tools will improve my rice yields and income	4.02	0.73	2nd	High
Digital extension tools save me time and reduce production costs	3.94	0.76	3rd	High
I intend to use digital extension tools regularly in my farming activities	3.86	0.77	4th	High

Willingness statement	Mean	SD	Rank	Decision
I trust the agricultural information I receive through digital platforms	3.79	0.79	5th	High
I would recommend digital extension tools to other rice farmers	3.71	0.82	6th	High
Digital extension tools are easy for me to understand and use	3.58	0.84	7th	High
Mean willingness index	3.87	0.74	,	Mod–High

Note: Scale: 1 = Strongly Disagree; 5 = Strongly Agree. Decision rule: mean ≥ 3.50 = Willing. SD = standard deviation. Source: Field Survey, 2026

Effect of Willingness on Rice Output

Table 3 presents the OLS regression results for the effect of willingness and control variables on rice output. The overall model was statistically significant ($F(6, 93) = 19.847$; $p < .001$) and explained 56.1% of the variance in rice output ($R^2 = .561$; adjusted $R^2 = .534$), indicating adequate explanatory power. Willingness was the strongest standardised predictor of rice output (B = 298.41; β = .404; $p < .001$), confirming that each unit increase in the willingness index was associated with an additional 298.41 kg of rice per season after controlling for other factors. This finding supports the rejection of the null hypothesis: farmers' willingness to use digital extension tools has a significant positive effect on rice output in Lafia LGA. The direction and magnitude of this effect are consistent with recent experimental evidence that engagement with digital extension services substantially raises rice yields (Karki Nepal *et al.,* 2025), that agricultural information provision improves smallholder technology adoption and output (Waje *et al.,* 2024), and that farmers' perceptions of the usefulness of digital platforms shape their productive engagement with them (Akinwale *et al.,* 2023).

Farm size was the second strongest predictor (B = 412.63; β = .381; $p < .001$), confirming the scale–productivity relationship in smallholder rice systems. Educational level was significant (B = 38.74; β = .218; p = .006), consistent with evidence that better-educated farmers engage more effectively with digital agricultural information and that socio-economic factors more broadly shape ICT use for accessing agricultural information (Abioye *et al.,* 2024; Makwin *et al.,* 2024). Extension contact (B = 76.42; p = .018) and farming experience (B = 16.82; p = .024) were also positive and significant, while age was not (p = .183). The significant contribution of extension contact alongside willingness accords with evidence that digital advisory services are most effective when combined with conventional extension support (Karki Nepal *et al.,* 2025), and reinforces the caution that structural constraints such as poor rural infrastructure and personnel shortages can blunt the productivity gains of digital extension unless deliberately addressed (Anteneh & Melak, 2024). All variance inflation factors were below 3.0, confirming the absence of serious multicollinearity; taken together, the results indicate that willingness operates alongside, rather than in place of, conventional productive resources and extension support in raising rice output.

Table 3: Effect of Willingness and Control Variables on Rice Output

Variable	B	Std. error	Beta (β)	t-value	Sig.
Constant	167.84	138.42	,	1.212	.228
Willingness index (X_1)	298.41	79.62	.404	3.748	.000
Age (X_2)	9.64	7.18	.104	1.342	.183
Educational level (X_3)	38.74	13.82	.218	2.803	.006
Farm size, ha (X_4)	412.63	92.14	.381	4.478	.000
Farming experience (X_5)	16.82	7.42	.174	2.267	.024
Extension contact (X_6)	76.42	32.14	.187	2.378	.018

Note: Dependent variable = rice output (kg/season). $R^2 = .561$; adjusted $R^2 = .534$. All VIFs < 3.0. Source: Field Survey, 2026

Conclusion

The study concludes that farmers' willingness to use digital extension tools is a significant and positive determinant of rice output in Lafia LGA, Nasarawa State, and that the moderate-to-high willingness index (3.87) recorded among respondents provides a solid attitudinal foundation for scaling digital extension, provided the structural barriers of poor connectivity, weak digital literacy, and limited extension contact that currently constrain its full productivity potential are addressed. It is therefore recommended that government and telecommunication agencies subsidies agricultural data bundles and expand rural network infrastructure, and that extension agencies and farmer cooperatives , to which 54% of respondents belong , be leveraged to deliver digital advisory content in Hausa and other local languages, prioritizing farmers with limited education and extension contact.

Acknowledgements

The authors acknowledge the rice farmers in Lafia Local Government Area who participated in the survey and the Nasarawa Agricultural Development Programme (NADP) for granting access to the community and farmer registers used for sampling.

REFERENCES

Abioye, D. O., Popoola, O., Akande, A., Fadare, D. A., Omitoyin, S. A., Yinusa, B., & Kolade, O. O. (2024). Farmers' willingness to adopt digital application tools in Ogun State, Nigeria. *Journal of Strategy and Management.* Advance online publication. https://doi.org/10.1108/JSMA-06-2023-0135

Akinwale, J. A., Oluwole, B. O., & Wole-Alo, F. I. (2023). Digital platforms for linking investors with smallholder farmers in Nigeria. *Journal of Agricultural Extension, 27*(2), 65–72. https://doi.org/10.4314/jae.v27i2.6

Amoussohoui, R., Arouna, A., Bavorova, M., Verner, V., Yergo, W., & Banout, J. (2024). Analysis of the factors influencing the adoption of digital extension services: Evidence from the RiceAdvice application in Nigeria. *The Journal of Agricultural Education and Extension, 30*(3), 387–416. https://doi.org/10.1080/1389224X.2023.2222109

Anteneh, A., & Melak, A. (2024). ICT-based agricultural extension and advisory service in Ethiopia: A review. *Cogent Food & Agriculture, 10*(1), Article 2391121. https://doi.org/10.1080/23311932.2024.2391121

Aremu, T., & Reynolds, T. W. (2024). Welfare benefits associated with access to agricultural extension services in Nigeria. *Food Security, 16*(2), 295–320.

Davis, F. D., Granić, A., & Marangunić, N. (2023). *The Technology Acceptance Model: 30 years of TAM.* Springer. https://doi.org/10.1007/978-3-030-45274-2

FAO. (2022). *The state of food and agriculture 2022: Leveraging automation in agriculture for transforming agrifood systems.* Food and Agriculture Organization of the United Nations. https://doi.org/10.4060/cb9479en

GSMA. (2024). *The mobile economy Sub-Saharan Africa 2024.* GSMA Intelligence. https://www.gsma.com/mobileeconomy/sub-saharan-africa/

Karki Nepal, A., Choudhary, D., Pandit, N. R., & Khanal, N. (2025). Impact of training and digital extension services on agricultural technology adoption and rice yields. *PLOS ONE, 20*(12), Article e0337456. https://doi.org/10.1371/journal.pone.0337456

Makwin, M. F., Bako, S. A., Selzing, P. M., & Dalla, A. A. (2024). Socio-economic factors influencing the use of information and communication technology for accessing agricultural information among cowpea farmers in Alkaleri Local Government Area of Bauchi State, Nigeria. *Journal of Applied Sciences and Environmental Management, 28*(5).

National Population Commission. (2023). *2023 provisional population figures by state and local government area.* National Population Commission.

Nigerian Communications Commission. (2024). *Industry statistics: Subscriber data.* https://www.ncc.gov.ng/statistics-reports/industry-overview

Nigerian Meteorological Agency. (2024). *Nigeria climate review bulletin 2024.* Nigerian Meteorological Agency. https://www.nimet.gov.ng

Sen, L. T. H., Chou, P., Dacuyan, F. B., Nyberg, Y., & Wetterlind, J. (2024). Barriers and enablers of digital extension services' adoption among smallholder farmers: The case of Cambodia, the Philippines and Vietnam. *International Journal of Agricultural Sustainability, 22*(1), Article 2368351. https://doi.org/10.1080/14735903.2024.2368351

Sen, L. T. H., Phuong, L. T. H., Chou, P., Dacuyan, F. B., Nyberg, Y., & Wetterlind, J. (2025). The opportunities and barriers in developing interactive digital extension services for smallholder farmers as a pathway to sustainable agriculture: A systematic review. *Sustainability, 17*(7), Article 3007. https://doi.org/10.3390/su17073007

Waje, S. S., Shano, B. K., Walelign, S. Z., & Kassie, W. A. (2024). The effect of agricultural information provision on smallholders' technology adoption and yield: Experimental evidence from Ethiopia. *Frontiers in Sustainable Food Systems, 8*, Article 1421442. https://doi.org/10.3389/fsufs.2024.1421442

©2026 This is an Open Access article distributed under the terms of the Creative Commons Attribution 4.0 International license viewed via https://creativecommons.org/licenses/by/4.0/ which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is cited appropriately.